APPENDIX B
DEVELOPMENT OF RISK-BASED TARGET LEVELS

The procedure used to calculate Tier 1 risk-based target levels (RBTLs) and Tier 2 site-specific target levels (SSTLs) is presented in this appendix. This procedure requires quantitative values of:

- Target risk levels,
- Chemical-specific toxicological factors,
- Physical and chemical properties of the chemicals of concern (COCs),
- Receptor-specific exposure factors,
- Fate and transport parameters, and
- Mathematical models.

Each of these factors is discussed below. Additionally, this Appendix discusses the (i) target levels for lead (Section B.8), and (ii) estimation of risk and target levels when LNAPL is present on the groundwater surface (Section B.9).

For Tier 1 risk assessments, the RBTLs have been calculated by MDNR for each of the COCs (refer to Section 5.3.3), the receptors (refer to Section 6.1.2), and the commonly encountered routes of exposure (refer to Section 6.1.3) using conservative assumptions applicable to most Missouri sites. The resultant Tier 1 RBTLs are presented in Tables 7-1(a) through (f).

For Tier 2 and Tier 3 risk assessments, the risk evaluator will calculate the SSTLs using technically justifiable site-specific data and, for Tier 3, pathway-specific models. For Tier 2 risk assessments, the models used for developing the Tier 1 RBTLs must be used. A Tier 3 risk assessment may include different models, if approved by MDNR.

B.1 TARGET RISK LEVELS

A risk-based decision making process requires the specification of a target risk level for both carcinogenic and non-carcinogenic adverse health effects. For carcinogenic effects, MDNR will use an **individual excess lifetime cancer risk (IELCR) of 1 x 10^{-5}** as the target risk for both current and future receptors. For non-carcinogenic effects, the acceptable level is a hazard quotient of one (1) for current and future receptors. Due to the limited number of COCs, additivity of risk is not considered.

For evaluating the ingestion of groundwater and protection of groundwater resource pathways, Maximum Contaminant Levels (MCLs) or, where MCLs are not available, health advisories were used as the target concentrations at the point of exposure. For chemicals that do not have such levels, the target concentration at the point of exposure (POE) was estimated assuming ingestion of groundwater under residential conditions.

Potential impacts to streams and other surface water bodies from a release must be evaluated and surface water quality protected as per 10 CSR 20-7.031. Allowable concentrations in surface water for COCs are presented in Table 6-1.

B.2 QUANTITATIVE TOXICITY FACTORS

Toxicity values for the COCs are presented in Table B-1. MDNR may update the data in Table B-1 as new information becomes available.

Typically, these toxicity values will also be used for Tier 3 risk assessments, although alternate values may be used at Tier 3 with adequate justification and the approval of MDNR. Current toxicity values may be obtained by consulting the following sources in the order listed:

- State recommended values,
- Integrated Risk Information System (IRIS),
- Direct communication with appropriate US EPA personnel, and
- Review of literature produced by qualified professionals to develop toxicity factors. Consult the appropriate Regional US EPA Office and MDNR for specific recommendations.

Note that the use of different values in a Tier 3 risk assessment will require a work-plan approved by MDNR.

B.3 PHYSICAL AND CHEMICAL PROPERTIES OF THE COCs

Physical and chemical properties of the COCs are listed in Table B-2. These values must be used for all MRBCA evaluations unless there are justifiable reasons to modify these values and MDNR concurs. The use of different values would be allowed only under a Tier 3 risk assessment.

B.4 EXPOSURE FACTORS

A list of the exposure factors and their values that were used to develop Tier 1 RBTL values is presented in Table B-3. The exposure factors are typically estimated based on literature rather than site-specific measurements. The values listed in Table B-3 are conservative values that are exceeded by about 5% of the population, i.e. they are the upper 95^{th} percentile values. For a Tier 3 risk assessment, site-specific exposure factor values may be used with thorough justification and MDNR approval.

A source of exposure factor information is U.S. EPA's **Exposure Factors Handbook Volume 1 – General Factors (*August 1997*).** Other sources of exposure factor data may be used for Tier 3 risk assessment with approval of MDNR**.**

B.5 FATE AND TRANSPORT PARAMETERS

Fate and transport parameters are necessary to estimate the target levels for the indirect routes of exposure. These factors characterize the physical site properties such as depth to groundwater, soil porosity, and infiltration rate at a site. For a Tier 1 risk assessment, MDNR has selected typical and conservative default values that are listed in Table B-4.

For a Tier 2 risk assessment, a combination of site-specific and default fate and transport values may be used. However, the value of each parameter used, whether site-specific or default, must be justified based on site-specific conditions. Where site- specific conditions are significantly different from the Tier 1 assumptions, site-specific values should be used.

For a Tier 3 risk assessment, the specific fate and transport parameters required to calculate the target levels will depend on the model used.

B.6 MATHEMATICAL MODELS

The input parameters mentioned above are used in two types of models, or equations, to calculate the risk-based target levels. These are the (i) uptake equations and (ii) fate and transport models. For Tier 1 and Tier 2 risk assessments, MDNR has selected the models and equations included in this appendix. These models have been programmed in the MRBCA Computational Software and were used to develop the Tier 1 target levels presented in Section 7.0.

For Tier 2 risk assessments, MDNR requires the use of the same equations and models. With the prior approval of MDNR through the submittal of a Tier 3 work plan, a different set of models may be used for Tier 3 risk assessments.

B.7 RISK-BASED TARGET LEVELS

The input parameters and models mentioned above are used to estimate risk-based target levels for each chemical and each route-of-exposure. For certain chemicals, the target levels developed for groundwater may exceed the solubility of a chemical. In such cases, the software indicates the actual calculated value with an asterisk that indicates that the calculated values exceed solubility. Similarly, for certain chemicals and pathways, soil target levels may exceed levels at which the soil is saturated by the chemical. In this case, the software presents the actual value with an asterisk that indicates that the calculated value exceeds the soil saturation value.

For both the above cases, the results can be interpreted to mean that the chemical and the pathway do not need any further evaluation and that the site-specific concentrations are protective of the pathway. Further, if concentrations above the solubility level in groundwater and above the soil saturation level are measured in a sample, the implication is that the sample had some free product in it.

B.8 TARGET LEVELS FOR LEAD

Lead has a number of toxic effects, but the main target for lead toxicity is the nervous system. Young children are especially vulnerable from the standpoints of both exposure and toxicity. Certain behaviors, such as crawling and playing on the floor or ground, result in increased exposure, and the central nervous system of a young child is particularly susceptible because it is still developing. Chronic exposure to even low